

Klamath Falls 2021 Exceptional Event EPA Concurrence Request

Submitted to: EPA, Region 10

By: Tori Heroux, Margaret Miller and Anthony Barnack

December 19, 2022

Commented [CV1]: Hi Tori, thank you for providing this draft for our review. It was interesting to read. We reviewed this document with an eye towards streamlining and you will see some comments on that. We have also provided comments for clarification and we made a few copyedits we noticed along the way. Please let me know if you have any questions. --- Claudia

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¹ Due to file size, appendices are included as stand alone documents.

Executive Summary

To address high monitor values resulting from exceptional events not reasonably controllable or preventable, the U.S. Environmental Protection Agency promulgated the Exceptional Events Rule (EER) pursuant to Section 319 of the Clean Air Act. Major changes to the 2007 EER contained in the Code of Federal Regulations, Title 40, Parts 50 and 51 (40 CFR 50 and 51) were promulgated on October 3, 2016 (72 FR 13560) to clarify the scope of the rules, analyses, content, and organization for exceptional events demonstrations, and fire related definitions and demonstration components. The EER allows states to flag air quality data as exceptional and exclude those data from use in determining compliance with the National Ambient Air Quality Standards if EPA concurs with the state's demonstration that it satisfies the rule requirements.

Following the EER procedures, Oregon Department of Environmental Quality (DEQ) flagged values at the Klamath Falls Peterson School monitor and is requesting concurrence from EPA that certain flagged values (**Table 1**) are exceptional events. The PM_{2.5} flagged values close to or over 35 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) affect Oregon's compliance with the 2006 24-hour PM_{2.5} NAAQS. DEQ demonstrates in this report and requests EPA concurrence that these exceptional concentration values occurred as a result of wildfires, they were not reasonably controllable or preventable by the State of Oregon, not likely to reoccur, and they fully meet the EER criteria for excluding monitor values from the data used to determine compliance with NAAQS. We are only requesting concurrence for days that are of regulatory significance, and are providing information for days that may become regulatorily significant in the future. A measurement is considered regulatory significant when it could impact the designation of the non-attainment area. Regulatory significance is based on a three-year rolling annual average of the 98th percentile of PM_{2.5} measurements. Therefore a measurement may become regulatorily significant in the future when more data is collected.

Table 1 below shows the key fires or fire complexes causing exceptional event days in the Klamath Falls Air Quality Monitoring Area (AQMA). In the demonstration, we are showing the data from the federal reference monitor (FRM), the Nephelometer and the federal equivalent monitor (FEM) Teledyne T640x/BAM1022 located at Peterson School. The T640x was the monitor in the Klamath Falls AQMA used to demonstrate compliance with the PM NAAQS for the first half of 2021. It was determined that the monitor was biased high by sixty percent on average compared to the co-located FRM filter-based sampler. On July 15, 2021, DEQ replaced the T640x monitor with a BAM1022. All subsequent values from that date forward—which includes the entirety of fire season and all of the dates in the tables included—were recorded using the BAM1022. The accuracy of the BAM1022, by comparison, is within ten percent. Oregon is no longer using the T640x. DEQ is presenting all data sets in this report to demonstrate all 2021 exceptional events.

Commented [WS2]: is this an ok way to put this? From what I remember, this isn't incorrect, but is narrower than "decision making".

Commented [CV3R2]: Good point, here is the CAA 319(b) language
 "determinations by the Administrator with respect to exceedances or violations of national ambient air quality standards."

Table 1. Monitor Values at Klamath Falls for which DEQ is Requesting EPA Concurrence*Sorted by Date²*

Date	24-Hour Average PM2.5 (µg/m3) EPA # 41-035-0004, POC 1			Flag	Source(s)
	FEM	FRM	NEPH		
7/25/2021	30.0	-	34.5	IT	Bootleg Fire, OR
8/3/2021	32.5	-	37.7	IT	Antelope and Dixie – CA
8/4/2021	65.1	-	75.2	RT	Antelope and Dixie – CA
8/5/2021	80.3	-	91.0	RT	Devils Knob Complex, Rough Patch Complex – OR
8/7/2021	43.5	-	48.9	RT	Devils Knob Complex, Rough Patch Complex – OR
8/9/2021	47.3	-	54.1	RT	Antelope – CA
8/10/2021	49.7	-	57.7	RT	Devils Knob Complex, Rough Patch Complex – OR
8/11/2021	80.1	-	93.8	RT	Devils Knob Complex, Rough Patch Complex – OR
8/12/2021	111.2	-	129.9	RT	Devils Knob Complex, Rough Patch Complex – OR
8/13/2021	130.5	-	158.1	RT	Devils Knob Complex, Rough Patch Complex – OR McCash, River Complex – CA
8/14/2021	133.4	132	161.0	RT	Devils Knob Complex, Rough Patch Complex – OR
8/15/2021	125.6	-	145.9	RT	Devils Knob Complex, Rough Patch Complex – OR
8/17/2021	81.8	-	93.9	RT	Devils Knob Complex, Rough Patch Complex – OR
8/18/2021	36.3	-	38.1	IT	Devils Knob Complex, Rough Patch Complex – OR
8/19/2021	63.7	-	67.8	RT	Devils Knob Complex, Rough Patch Complex – OR
8/20/2021	73.1	-	75.9	RT	Devils Knob Complex, Rough Patch Complex – OR
8/21/2021	78.2	-	82.5	RT	Devils Knob Complex, Rough Patch Complex – OR
8/22/2021	63.3	-	69.8	RT	Monument, McCash, River Complex – CA
8/23/2021	62.9	-	71.1	RT	Devils Knob Complex – OR, Monument – CA
8/24/2021	69.9	-	78.3	RT	Antelope, Monument – CA
8/25/2021	68.8	-	77.3	RT	Devils Knob Complex – OR, Monument – CA
8/26/2021	57.1	61.9	63.6	RT	Devils Knob Complex, Rough Patch Complex – OR
8/27/2021	85.8	-	95.0	RT	Devils Knob Complex, Rough Patch Complex – OR
8/28/2021	25.2	-	29.0	IT	Devils Knob Complex, Rough Patch Complex – OR
8/29/2021	41.5	-	48.4	RT	Devils Knob Complex – OR, McCash – CA
8/30/2021	78.5	-	95.0	RT	Devils Knob Complex – OR, McCash – CA
8/31/2021	58.0	-	68.1	RT	Devils Knob Complex, Rough Patch Complex – OR
9/1/2021	55.0	55.3	62.7	RT	Devils Knob Complex, Rough Patch Complex – OR
9/2/2021	31.5	-	35.8	IT	Devils Knob Complex, Rough Patch Complex – OR
9/3/2021	38.8	-	44.7	RT	Devils Knob Complex – OR, Antelope – CA
9/4/2021	77.8	-	89.5	RT	Devils Knob Complex – OR
9/5/2021	86.3	-	98.9	RT	Antelope, Monument – CA
9/6/2021	55.9	-	65.3	RT	Antelope, Monument – CA

Commented [CV4]: It's not clear to me what the bold means.

² Please note that RT means days with wildfire smoke impacts that do have regulatory significance and IT means days with wildfire smoke impacts that are being flagged for information purposes only.

2021 Klamath Falls Wildfire Exceptional Events

9/7/2021	50.2	52.3	57.2	RT	Antelope, Monument – CA
9/8/2021	71.1	-	80.1	RT	Devils Knob Complex – OR, Antelope, Monument - CA
9/9/2021	80.2	-	92.7	RT	Antelope, Monument – CA
9/10/2021	43.0	-	51.3	RT	Antelope, Monument – CA
9/11/2021	29.3	-	34.0	IT	Antelope, Monument – CA
9/12/2021	25.3	-	30.5	IT	Antelope, Monument – CA
9/15/2021	37.9	-	41.9	RT	Devils Knob Complex – OR
9/16/2021	25.1	-	27.7	IT	Devils Knob Complex – OR
9/17/2021	29.5	-	33.0	IT	Devils Knob Complex – OR

In addition, **Table 2A** and **Table 2B** show that the requested values are the highest values recorded at the respective monitors for summer days (July 22 to October 9) from 2013-2021. **Table 2A** includes the data from the T640x and BAM1022 for 2019 through 2021. **Table 2B** shows the same data for 2013 to 2018 but uses the FRM for 2019 through 2021. Exceptional events days from prior years, with the exception of 2018,³ that have been concurred by EPA are included in these tables.

Table 2A. Rank Percent of Requested Values, 2013-2021; July 25 – September 17; Klamath Falls Monitor. FRM 2013 to 2018 and T640x 2019 to halfway through 2021 then replaced with a BAM 1022

Monitor	Date	Year	PM2.5 (µg/m3)	Flag	Rank (N=450)	PCTL
T640x	9/12/2020	2020	458	RT	450	100%
T640x	9/13/2020	2020	286	RT	449	62%
T640x	9/11/2020	2020	215	RT	448	47%
FRM	8/3/2018	2018	156	IT	447	34%
FRM	8/6/2018	2018	156	IT	446	34%
FRM	7/31/2018	2018	146	IT	445	32%
BAM1022	8/14/2021	2021	133	RT	444	29%
BAM1022	8/13/2021	2021	130	RT	443	29%
BAM1022	8/15/2021	2021	126	RT	442	27%
FRM	8/9/2018	2018	125	IT	441	27%
FRM	8/21/2018	2018	116	IT	440	25%
BAM1022	8/12/2021	2021	111	RT	439	24%
FRM	7/28/2018	2018	111	IT	438	24%
FRM	9/4/2017	2017	102	RT	437	22%
FRM	7/25/2018	2018	98	IT	436	21%
T640x	8/24/2020	2020	98	RT	435	21%
T640x	10/8/2020	2020	96	RT	434	21%
T640x	9/23/2020	2020	94	RT	433	21%
FRM	8/15/2018	2018	93	IT	432	20%
T640x	8/23/2020	2020	89	RT	431	20%
T640x	9/5/2020	2020	88	RT	430	19%
BAM1022	9/5/2021	2021	86	RT	429	19%
BAM1022	8/27/2021	2021	86	RT	428	19%

Commented [CV5]: This date range doesn't match the date ranges in the table headings.

Commented [WS6R5]: I'm also confused about what is meant by "requested values" -- I assumed the ones requested in this demo document for 2021, but there are six days with higher PM2.5 than the highest 2021 day.

Commented [CV7]: It looks like table 2B shows only the FRM data for this time period. Also, I don't think it's the same data. Table 2B seems to have more FRM data than table 2A for 2013-2018.

FRM	8/5/2013
FRM	8/29/2017
FRM	8/26/2021
FRM	8/24/2018
FRM	9/1/2021
FRM	8/20/2017

Commented [WS8R7]: I am guessing that this is included because of the issues with the T640X, i.e., to show the difference between the T640X (which was the primary monitor) and the FRM on days when they both ran.

Commented [WS9R7]: I don't think table 2B adds much value to the report.

Commented [CV10R7]: In the spirit of streamlining, maybe it can be removed.

Commented [KR11]: In the spirit of simplifying EE demos, I'm not clear on the utility of providing this column. Also I'm not clear on how this is being calculated, i.e., the rank from row 1 to row 2 is 450 and then 449, but the percentile jumps way down ...

Having said that, it might be useful if it were just the data for 2021 for the whole year, to demonstrate the significance to the 98th percentile.

Commented [WS12R11]: I agree, Bob! I find this confusing as well.

³ A 2018 Exceptional Events Demonstration will not be submitted because it is no longer of regulatory significance.

2021 Klamath Falls Wildfire Exceptional Events

FRM	8/1/2015	2015	85	RT	427	19%
BAM1022	8/17/2021	2021	82	RT	426	18%
BAM1022	8/5/2021	2021	80	RT	425	18%
BAM1022	9/9/2021	2021	80	RT	424	18%
BAM1022	8/11/2021	2021	80	RT	423	17%
FRM	7/30/2013	2013	80	RT	422	17%
BAM1022	8/30/2021	2021	78	RT	421	17%
BAM1022	8/21/2021	2021	78	RT	420	17%
BAM1022	9/4/2021	2021	78	RT	419	17%
T640x	7/28/2020	2020	77	RT	418	17%
T640x	9/14/2020	2020	75	RT	417	16%

Table 2B. Rank Percent of Requested Values, 2013-2021; August 14 – September 7; Klamath Falls FRM Monitor

Monitor	Date	Year	PM2.5 (µg/m3)	Flag	Rank (N=224)	PCTL
FRM	9/12/2020	2020	300	RT	224	100%
FRM	8/3/2018	2018	156	RT	223	52%
FRM	8/6/2018	2018	156	RT	222	52%
FRM	7/31/2018	2018	146	RT	221	49%
FRM	8/14/2021	2021	132	RT	220	44%
FRM	8/9/2018	2018	125	RT	219	42%
FRM	8/21/2018	2018	116	RT	218	39%
FRM	7/28/2018	2018	111	RT	217	37%
FRM	9/4/2017	2017	102	RT	216	34%
FRM	7/25/2018	2018	98	RT	215	33%
FRM	8/15/2018	2018	92.6	RT	214	31%
FRM	8/1/2015	2015	84.8	RT	213	28%
FRM	7/30/2013	2013	79.8	RT	212	27%
FRM	8/5/2013	2013	74.8	RT	211	25%
FRM	8/29/2017	2017	69.3	RT	210	23%
FRM	8/26/2021	2021	61.9	RT	209	21%
FRM	8/24/2018	2018	55.5	IT	208	19%
FRM	9/1/2021	2021	55.3	RT	207	18%
FRM	8/20/2017	2017	55.1	IT	206	18%
FRM	9/7/2021	2021	52.3	RT	205	17%

Commented [KR13]: Same comment as above

Required Elements of the Exceptional Event Rule

The EER requires that demonstrations justifying data exclusion as exceptional event must include the following:

- A narrative conceptual model that describes the event(s) causing the exceedance of violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s);
- A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation;

- (c) Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times to support the clear causal relationship requirement;
- (d) A demonstration that the event was both not reasonably controllable and not reasonably preventable;
- (e) A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event; and
- (f) Documentation that the State followed the public comment process and conducted at least a 30-day comment period.

In addition, a state must submit the public comments with the demonstration and address in the demonstration those comments disputing or contradicting factual evidence provided in the demonstration (40 CFR 50.14). DEQ organized the demonstrations by sections that address each element of the EER (*Table 3*).

Table 3. Summary of Elements Included in this Demonstration.		
EER Element	Section	Summary
Conceptual Model	1	The conceptual model describes the affected area, meteorological conditions of the region, and the source causing the violation. It includes a discussion of how emissions from the wildfire event led to the violation at the Klamath Falls monitor.
Clear Causal Relationship	2	Data are presented to demonstrate that the event affected air quality and that there is a clear causal relationship between the event and the exceedances: <ul style="list-style-type: none"> (1) Meteorological evidence: transport of emissions to monitor (2) Satellite and back trajectory evidence: spatial relationship between source and monitor (3) Time series evidence: temporal description of event days (4) Alternative sources
Historical Concentrations	3	Analyses comparing the event-influenced concentrations at Klamath Falls to historical concentrations.
Not Reasonably Controllable or Preventable	4	A wildfire event meets the EER for this element (40 CFR 50.14(b)(4))
Human Activity Unlikely to Recur at a Particular Location or a Natural Event	5	The criterion meets the EER definition that wildfires predominantly occurring on wildland are natural events.
Mitigation	6	DEQ presents evidence of prompt public notification of the event, public education so that individuals could make behavioral changes to reduce exposure to unhealthy air, and implementation of appropriate measures to protect public health from the impacts of exceptional events.
Initial Notification	7	Demonstration of initial notification to EPA.
Public Comments	8	Documentation of the public comment process, public comments received and DEQ response to comments.

Introduction

DEQ requests an exclusion of the measured exceedances of the 24-hour PM_{2.5} (fine particulate matter) National Ambient Air Quality Standards at Klamath Falls, Oregon, on the days outlined in *Table 1* above. This demonstration provides evidence and narrative satisfying all the requirements set forth in the

Exceptional Events Rule. The exceedances were the direct result of wildfire events that affected air quality at the respective monitors.

The conceptual model describes the event and how the emissions from the events led to the exceedances at each monitor on each day. It demonstrates that a clear causal relationship exists between the event and the monitored exceedance. We compared the historical concentrations at the Klamath Falls monitor to the exceedance concentrations to support the clear causal relationship requirement. The wildfire event was both not reasonably controllable and not reasonably preventable, and it was a natural event. DEQ provided prompt public notification of the event, provided for public education concerning actions that individuals may take to reduce exposures to unhealthy levels of air quality during the event, and provided for the implementation of appropriate measures to protect public health from the exceedances caused by the event. Public comments on the demonstration and DEQ's responses can be found in **Section 8**.

1 Conceptual Model

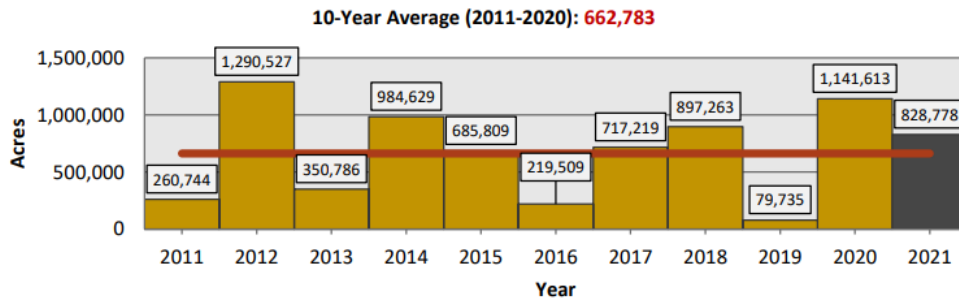
In July, August, and September of 2021, smoke from regional wildfires was transported to the Klamath Falls monitors. The Klamath Falls monitor recorded exceedances of the 24-hour PM_{2.5} NAAQS; 34 days from the FEM (BAM1022) and four days of FRM (identified in **Table 1** of this report and flagged as RT) have regulatory significance. Nine additional days on the BAM1022 have been identified for informational purposes, because they have the potential of becoming regulatorily significant. All of these occurrences ~~are~~ result from wildfires. The conceptual model describes the source of the fine particulate matter that impacted the monitor, the transport weather conditions that brought aerosols to the monitor, the estimated emissions of the wildfire sources, and the timing and magnitude of the events' impacts on the respective monitors.

1.1 Overview

Wildfires occur every year in the western United States during summer and fall. The 2021 wildfire season was, like most years, hot, dry, and smoky. Over 1.5 million acres burned in Oregon, Washington, and Idaho during the 2021 wildfire season. Oregon alone saw 828,778 acres burn.⁴

According to the 2021 Northwest Annual Fire Report, the Northwest's 2021 fire year surpassed historical averages for duration and fire activity. Fire Season was declared in parts of Oregon as early as May 12, 2021 and lasted roughly 131 days making it the fifth longest season in Oregon history. The 2021 fire season presented the PNW with a record-setting season length: the highest-ever number of days at Preparedness Levels 4 and 5 (76 days total) with additional days at Preparedness Level 3 (28 days). The 2021 fire season finally slowed to a Preparedness Level 1 on October 20th, with minimal fire activity from that point through the end of the calendar year. As depicted in **Figure 1** below, Oregon's total acres burned in 2021 is well above the 10-year average.

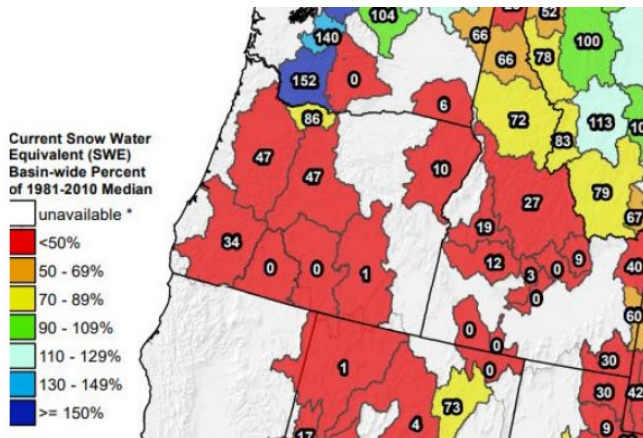
⁴ Northwest Interagency Coordination Center. Wildland Fire Summary and Statistics Annual Report, 2021. Portland, OR. https://www.predictiveservices.nifc.gov/intelligence/2021_statsumm/annual_report_2021.pdf (Accessed June 2022).

Figure 1. Total Wildfire Acres Burned in Oregon's 2021 vs. 10-Year Average, 2011-2020.

Smoke from Oregon and other large regional wildfires were transported into Klamath Falls monitors and caused 34 exceedences with regulatory significance and nine days that have been identified for informational purposes, because they have the potential of becoming regulatorily significant. As has happened in the past, smoke from California wildfires also impacted Oregon's southern border communities including Klamath Falls, OR.

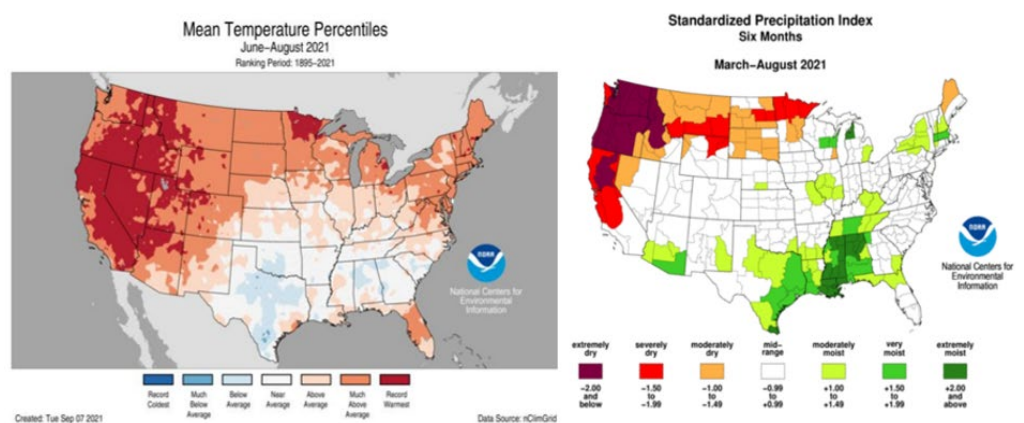
1.2 Transport Weather Conditions & Trends

The 2021 fire season kicked off earlier than normal as the region experienced a dry spring and low snowpacks levels due to an ongoing drought. **Figure 2** below shows how in late May, most of Oregon's basin snow water equivalent levels were between 0% and 47% of seasonal normal. **Figure 3** below shows mean temperature percentiles from June – August 2021 and standardized precipitation index from March – August 2021. In Oregon, August brought lightning that generated several new fire starts along the west slopes of the Cascades from the Mount Hood area down to the Umpqua Divide. Some of these new fires were adjacent to current managed large fires that impacted strategic planning greatly. Initial attack activity and extended attack activity taxed teams in place as multiple new starts were merged into four complexes.

Figure 2. Snow Water Equivalent as of May 31, 2022⁵

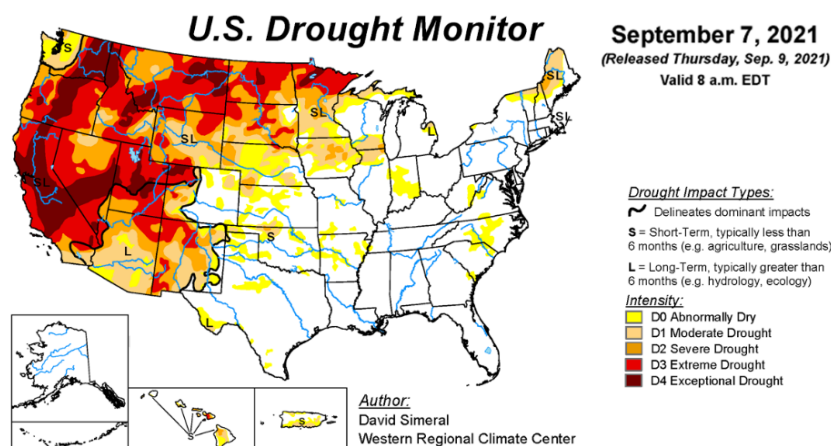
⁵ Figure 2-4 were drawn from the Northwest Interagency Coordination Center's 2021 Northwest Annual Fire Report, available at: https://gacc.nifc.gov/nwcc/content/pdfs/archives/2021_NWCC_Annual_Fire_Report.pdf

Figure 3. Mean Temperatures Percentiles from June – August 2021 and Standardized Precipitation Index from March – August 2021.



The very dry trend observed in July and August 2021 across the region continued through the first half of September (**Figure 4**, below). Daily values of minimum relative humidity and corresponding overnight recoveries maintained a worsening trend from late August through mid-September, falling steadily below average.

Figure 4. North American Drought Monitor Map for Sept. 7, 2021



1.3 Source Area and Affected Region

Klamath Falls is located in south central Oregon at an elevation of 4,105 feet. The City of Klamath Falls serves as an important commercial center for south central Oregon. The Klamath Basin is a relatively flat

area of an old high elevation lakebed that is drained by the Klamath River. Occasional hills and a system of elongated ridges confine the basin and the greater Klamath Falls area to the east and west. Most of the Klamath Falls residential area, especially the south suburban area, is located on the lower elevation area. Because of these features, Klamath Falls can experience very strong and shallow nighttime inversions that break up with daytime solar heating. In the wintertime, frigid arctic air masses frequently move down Upper Klamath Lake and invade the Klamath Basin. Temperatures can remain well below freezing for several weeks at a time. Under these conditions, these strong inversions occur over the Klamath Basin concentrating emissions in the south suburban area of Klamath Falls.

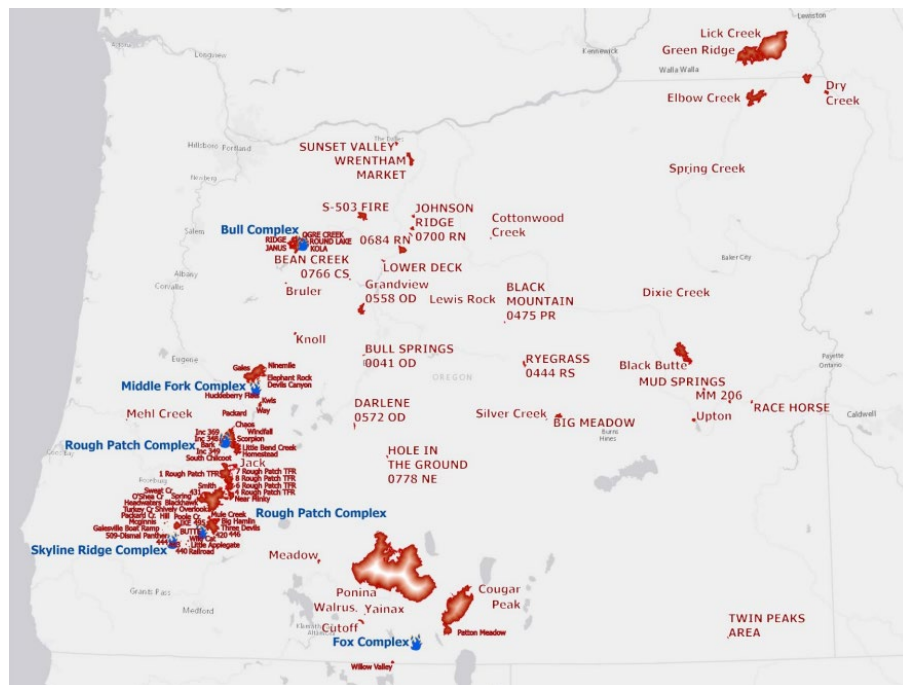
In 1987, Klamath Falls was designated a nonattainment area by the Environmental Protection Agency for PM₁₀ – particulate matter 10 microns and smaller. A PM₁₀ attainment plan was developed for the Klamath Falls Urban Growth Boundary by 1991. However, at that time the area still had not met the standard. DEQ subsequently revised the PM₁₀ plan and submitted an addendum to EPA in 1995. EPA approved both the attainment plan and the addendum on April 14, 1997. In 2002, DEQ submitted a maintenance plan for PM₁₀. EPA approved the PM₁₀ maintenance plan and Klamath Falls was redesignated to attainment for PM₁₀ on October 21, 2003. Both the attainment plan and maintenance plan included a key strategy of a mandatory woodstove curtailment program and a large woodstove change-out program. This was accomplished through community involvement in Klamath Falls and the community addressing it at a local level through both ordinance and education of neighbor-to-neighbor. As a result, the area met and continues to meet the PM₁₀ standards.

In 1997, EPA revised the particulate standard to include PM_{2.5} and established a daily standard of 65 µg/m³. The original PM₁₀ strategies included in the Klamath Falls PM₁₀ attainment plan were so successful in maintaining clean air that Klamath Falls met the 1997 fine particulate (PM_{2.5}) standard. By 2006, however, EPA modified the PM_{2.5} standard again based on the latest health effects data, lowering it to 35 µg/m³. Klamath Falls has faced challenges in meeting the 2006 daily PM_{2.5} standard. DEQ has measured particulate at the same location in the Klamath Falls UGB (Peterson School on Clinton Street) since 1996 and conducted numerous saturation surveys to confirm Peterson School is still the appropriate location for the monitor. The latest of these saturation surveys was conducted in 2011.

Portions of Klamath Falls in Klamath County were designated as the Klamath Falls PM_{2.5} nonattainment area in 2009 with an attainment date on December 31, 2015. Klamath Falls was classified as moderate for PM_{2.5} on June 2, 2014 (79 FR 31566). In June 2016, EPA approved a finding of attainment and clean data determination for Klamath Falls, based on data from 2012-2014. In 2017, an exceptional events demonstration was submitted to and approved by the EPA on May 21, 2020. In 2018 wildfire smoke did impact monitors, but due to DEQ's staffing turnover and limitation, an exceptional events demonstration was not submitted in time for it to have regulatory significance. DEQ submitted an exceptional event demonstration for 2020, but has not yet received EPA's concurrence. It is important that the monitor values that meet the criteria for exceptional events for 2021 be excluded for Klamath Falls to be redesignated as an attainment area and demonstrate continued ability to meet the NAAQS for PM_{2.5}.

For Klamath Falls, 2021 wildfire smoke events happened throughout the summer with events in July, August, and September. Smoke not only resulted from Oregon's 2021 wildfires (*Figure 5*) but also as a result of wildfires in northern California.

Figure 5. Map of 2021 Oregon Large Wildfires



1.3.1 Key Wildfires or Multi-Source Smoke Events

The primary contributors to smoke in the Klamath Falls area were a result of several different wildfires including:

Antelope Fire

The Antelope Fire was first reported in the drainage of Antelope Creek in the Goosenest Ranger District of the Klamath National Forest in Siskiyou County, California on August 1, 2021, around 10:30 AM. The fire was one of many started by lightning strikes in the area during a thunderstorm. The fire was fueled by ponderosa pine, mixed conifer, and ponderosa pine which is usually very smoky. The Antelope Fire burned 145,632 acres before being deemed 100% contained in mid-October, 2021.

Commented [CV14]: I'm not sure if this edit is correct, if so, this sentence appears several times in the document.

Big Hamlin Fire

See the Devils Knob Complex Fire.

Bootleg Fire

The Bootleg Fire, named after the nearby Bootleg Spring, started on July 6, 2021, in the Fremont-Winema National Forest, approximately 15 miles northwest of the town of Beatty, Oregon. This lightning-caused fire burned through a variety of fuel types including mixed grass/shrub, timber understory, and timber with litter fuel types. Dense smoke was produced due to a heavy concentration of

snags, downed logs with shrubs (above 6500' elevation) in areas of beetle infestation die-off. This fire merged with a smaller fire (the Log Fire) on July 20, 2021. During its fastest growth this fire was growing at about 1,000 acres per hour. The Bootleg Fire was the second largest wildfire in the United States during the 2021 wildfire season. On August 15, 2021, it was deemed 100% contained and it had burned 413,765 acre.

Cronan Fire

See the River Complex Fire.

Devils Knob Complex Fire

The Devils Knob Complex on the Umpqua National Forest is a collection of 25 wildfires that started from lightning strikes on July 29 and August 1, 2021. The primary fuels were a mixed conifer/ponderosa overstory with several degrees of understory. Understory ranges from grass and light shrubs in the meadows and along the forest edges, to heavy dead and downed trees with cones and needles mixed in.

Figure 6: Smoke from the Devils Knob fires from Pickett Butte Lookout



Haypress Fire

See the River Complex Fire.

McCash Fire

The McCash Fire was reported on July 31, 2021, around 7:00 pm. The fire was burning in timber with an understory of tall grass and brush in rugged, steep terrain in an area with limited roads and partially within the Marble Mountain Wilderness. The nearest towns are Somes Bar and Happy Camp, CA (Siskiyou County). This fire was caused by lightning and was not completely contained until October 27, 2021, after burning 94,962 acres.

Monument

The Monument Fire (formerly known as the Panther Fire) was a wildfire west of Big Bar in Shasta-Trinity National Forest, Trinity County, California in the United States. The fire, which was started by a lightning strike, was first reported on July 30, 2021. This fire was 100% contained in late October after it had burned 223,124 acres.

Near Minky Fire

See the Rough Patch Complex Fire.

River Complex Fire

The River Complex 2021 was a wildfire complex burning in Klamath National Forest in Siskiyou County, California in the United States. The complex comprises over 20 wildfires that started as a result of lightning strikes during a series of thunderstorms in late July 2021. The fire had burned a total of 199,343 acres (80,671 ha) and wasn't 100% contained until October 25, 2021.

Rough Patch Complex Fire

The Rough Patch Complex on the Umpqua National Forest started July 29, 2021, when 20-plus lightning fires resulted from thunderstorms in the area. Several more fires were added to the Complex including the Jack Fire when another storm moved through August 1, bringing the total identified fires to 42.

Smith Fire

See the Devils Knob Complex Fire.

1.3.2 Methodology

In order to connect wildfire with days experiencing PM2.5 exceedences, DEQ consulted wind speed, wind direction and hourly PM2.5 readings and plotted against the time of day for the previous evening and 24-hour period of the impacted day. DEQ examined satellite smoke images from MODIS Terra and MODIS Aqua satellites for the day of the impacted monitor reading, for the central and southern Oregon region. These satellites tend to pass over the area that covers Klamath Falls from 10 a.m. to 1 p.m. of each day.

DEQ consulted HYSPLIT back trajectories calculated in AirNow-Tech, using the PM2.5-88502 parameter and 1-hour duration. The date and time was set to the time of day where the monitor reading was at its peak. Heights were set at 50 m, 500 m, and 1,000 m to capture near-ground and higher altitude wind transport, and the model was usually run for 8-24 hours. The results show approximately a one- to three-hour delay to the Klamath Falls monitor from the forest fire complexes in question for 2021. See [Appendix A](#) for more details on how the HYSPLIT trajectories are calculated.

Commented [CV15]: Bob, it's unclear to me what this phrase is saying, do you have any suggestions?

Commented [KR16R15]: I read it as they were providing data plots for each day, plus the previous evening. But the data plots I see are multi-day, so I'm not sure either.

Commented [CV17]: The appendices are separate documents and can be found in the file folder.

1.3.3 Klamath Falls Monitor Impacted Days & Emission Source

The following section is broken down by event. There is a July event, August event, and September event. Within each event is a description of days impacted, the emission source(s), and a time series of the PM2.5 readings at the Klamath Falls monitor. DEQ has also included satellite smoke images from MODIS Terra or MODIS Aqua satellites, wind speed, wind direction, and smoke sources using the HYSPLIT back or forward trajectory analysis. Due to the sheer number of days within certain events, DEQ did not show all daily satellite smoke images and HYSPLIT trajectory modeling results in the main body of this document, but has included those images—in the appendices and made them part of this demonstration.

July Event | July 25, 2021

The July 25th event was caused by smoke from the Bootleg Fire. The Bootleg Fire was reported on July 6, 2021 in the Fremont-Winema National Forest, approximately 15 miles northwest of the town of Beatty, Oregon. This lightning caused fire burned through a variety of fuel types including mixed grass/shrub, timber understory, and timber with litter fuel types. Dense smoke was produced due to a heavy concentration of snags, downed logs with shrubs (above 6,500' elevation) in areas of beetle infestation die-off. This fire merged with a smaller fire (the Log Fire) on July 20, 2021. During its fastest growth this fire was growing at about 1,000 acres per hour. The Bootleg Fire was the second largest wildfire in the United States during the 2021 wildfire season. On July 11, 2021 at 3:00pm wind directions shifted from W to NE bringing smoke in from the July Complex fire. Observed PM 2.5 levels elevated quickly at 3:00pm and stayed elevated above the 2006 PM2.5 standard until 2:00 pm on July 28, 2021. Diurnal wind speeds ranged from 0 MPH to approximately 6 MPH.

Figure 7A shows the time series (wind speed- WS, wind direction - WD, and hourly PM2.5 readings) at the Klamath Falls Peterson School monitor, while **Figure 7B** shows the MODIS satellite data and the aerosol optical depth of smoke over Klamath Falls. **Figure 7C** shows the HYSPLIT back trajectory for July 25th. This impacted day is for informational purposes only.

Commented [KR18]: I read this as observations in Klamath Falls, but none of these days are included in this EE demo, so it would be good to clarify.

Commented [WS19R18]: I'm also confused by the timeline. Furthermore, Figure 7A does not convey a jump in PM2.5 levels when the wind shifts.

Figure 7A. Klamath Falls July 25, 2021 PM2.5 and Wind Time Series

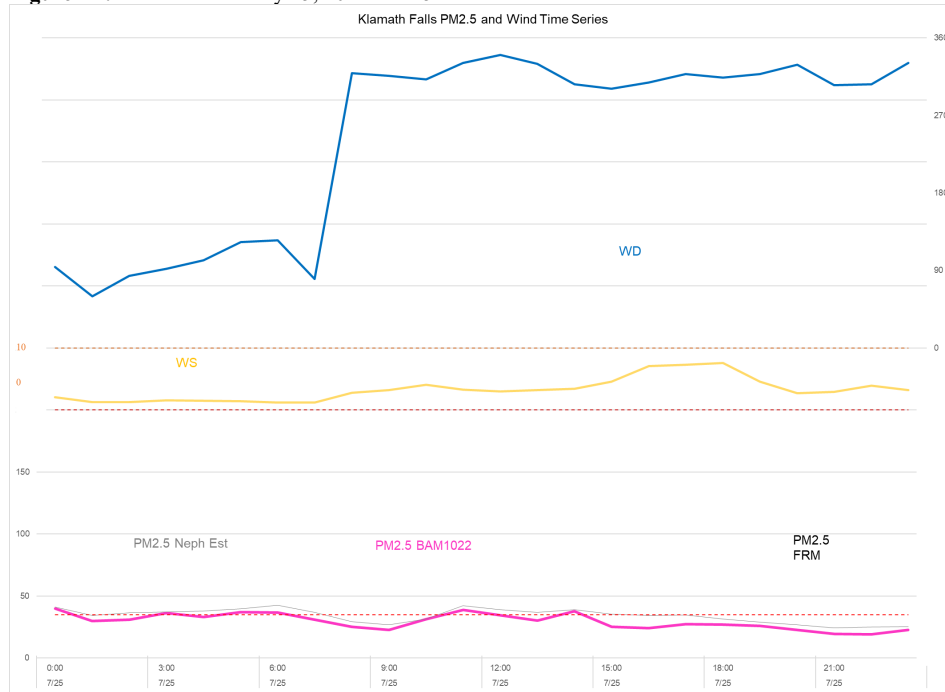


Figure 7B. Satellite Photos of Smoke Over Klamath Falls on July 25, 2021

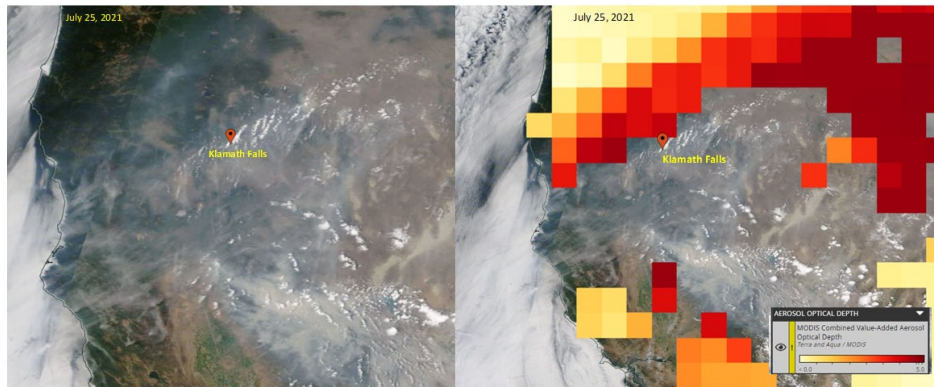
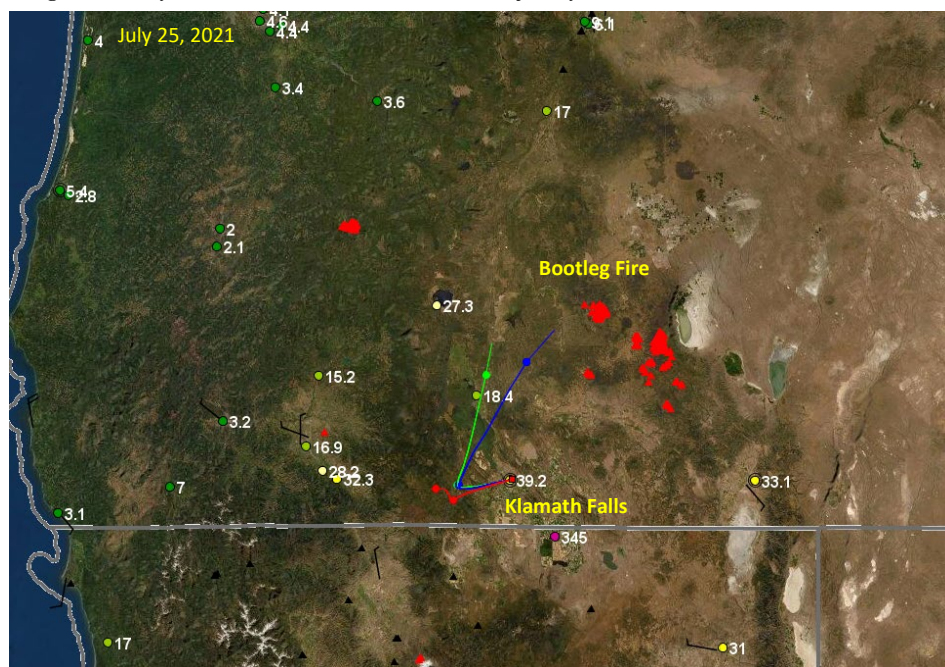


Figure 7C. July 25, 2021 HYSPLIT 12 Hour Back Trajectory from Klamath Falls

August Event | Aug 3-7, 2021; Aug 9-15, 2021; Aug 17-31, 2021

Table 4. August Events

Date	24-Hour Avg PM2.5 (µg/m3)			Flag
	FEM	FRM	NEPH	
8/3/2021	32.5		37.7	IT
8/4/2021	65.1	-	75.2	RT
8/5/2021	80.3	-	91.0	RT
8/7/2021	43.5	-	48.9	RT
8/9/2021	47.3	-	54.1	RT
8/10/2021	49.7	-	57.7	RT
8/11/2021	80.1	-	93.8	RT
8/12/2021	111.2	-	129.9	RT
8/13/2021	130.5	-	158.1	RT
8/14/2021	133.4	132	161.0	RT
8/15/2021	125.6	-	145.9	RT
8/17/2021	81.8	-	93.9	RT
8/18/2021	36.3		38.1	IT
8/19/2021	63.7	-	67.8	RT
8/20/2021	73.1	-	75.9	RT

2021 Klamath Falls Wildfire Exceptional Events

8/21/2021	78.2	-	82.5	RT
8/22/2021	63.3	-	69.8	RT
8/23/2021	62.9	-	71.1	RT
8/24/2021	69.9	-	78.3	RT
8/25/2021	68.8	-	77.3	RT
8/26/2021	57.1	61.9	63.6	RT
8/27/2021	85.8	-	95.0	RT
8/28/2021	25.2	-	29.0	IT
8/29/2021	41.5	-	48.4	RT
8/30/2021	78.5	-	95.0	RT
8/31/2021	58.0	-	68.1	RT

August was a particularly smoky month for Klamath Falls with the majority of the month being impacted by smoke from either the Devils Knob Complex Fire (which includes Big Hamlin fire, Little Applegate Fire, Mule Fire, Three Devils Fire, and the Wild Cat Fire) located in Oregon's southern Cascades or by fires in Northern California.

The Devils Knob Complex on the Umpqua National Forest is a collection of 25 wildfires started from lightning strikes primarily in mixed conifer/ponderosa forest. The Rough Patch Complex on the Umpqua National Forest started July 29, 2021 when 20-plus lightning fires resulted from

thunderstorms in the area. Several more fires were added to the Complex including the Jack Fire when another storm moved through August 1, bringing the total identified fires to 42. The Monument Fire (formerly known as the Panther Fire) was a wildfire west of Big Bar in Shasta-Trinity National Forest, Trinity County, California in the United States. The fire, which was started by a lightning strike, was first reported on July 30, 2021. The McCash Fire was reported on July 31, 2021 around 7:00 pm. The fire was burning in timber with an understory of tall grass and brush in rugged, steep terrain in an area with limited roads and partially within the Marble Mountain Wilderness. The nearest towns are Somes Bar and Happy Camp, CA (Siskiyou County). This fire was caused by lightning. The Antelope Fire was first reported in the drainage of Antelope Creek in the Goosenest Ranger District of the Klamath National Forest in Siskiyou County, California on August 1, 2021, around 10:30 AM. The fire was one of many started by lightning strikes in the area during a thunderstorm. The fire was fueled by ponderosa pine, mixed conifer, and ponderosa pine which is usually very smoky. The River Complex 2021 was a wildfire complex burning in Klamath National Forest in Siskiyou County, California in the United States. The complex comprises over 20 wildfires that started as a result of lightning strikes during a series of thunderstorms in late July 2021.

During the August event there were 23 regulatorily significant days and 3 days with PM 2.5 levels that were high due to wildfire smoke, but with monitoring values that don't currently have regulatory significance. We have included the PM2.5 values for all of these days in **Table 4**.

The August event was predominantly caused by smoke from Devils Knob Complex Fire and the Rough Patch Complex Fire located in Oregon northwest of Klamath Falls, or the Antelope and Monument Fires in California, south of Klamath Falls. All four of these fires generated a lot of smoke because they were timber fires. Smoke from this fire was impacting communities across northern California and southern Oregon, including Klamath Falls, OR.

On August 4, wildfire smoke impacted the Klamath Falls monitor. Wildfires flanked the community and impacted the community regardless of wind direction, particularly because wind speeds were low and forest fires were occurring both to the north and the south. Overnight inversions trapped smoke in the Klamath Basin. Observed PM 2.5 levels were highest in the evening of August 13th leading into the day of August 14th, but elevated levels continued throughout the month. PM 2.5 observations were highest when winds were coming from the South/Southwest. For more detail, see the time series below.

In the information provided below, **Figure 8A-1 through Figure 8A-5** show the time series (wind speed, wind direction, and hourly PM2.5 readings) at the Klamath Falls Peterson School monitor for all impacted days. **Figure 8B** shows the MODIS satellite data and the aerosol optical depth of smoke over Klamath Falls for August 14th (the date with the highest daily average). **Figure 8C** shows the HYSPLIT back trajectory and forwards trajectory for August 14th.

Daily satellite smoke images and reverse/forward HYSPLIT trajectory modeling results are available for all August event dates and can be found in *Appendix B*.

Figure 8A-1. Klamath Falls August 4-9, 2021 PM2.5 and Wind Time Series

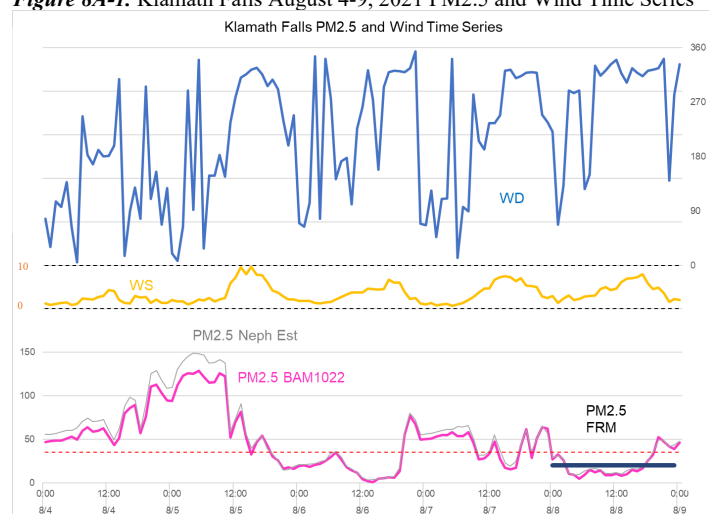


Figure 8A-2. Klamath Falls August 9-13, 2021 PM2.5 and Wind Time Series

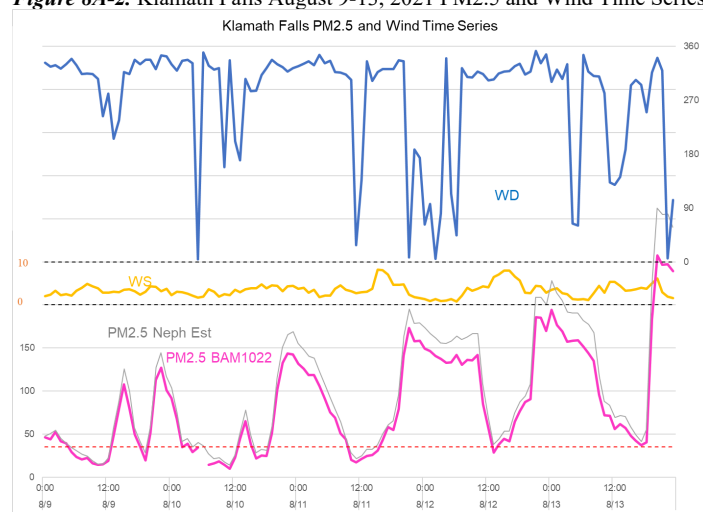


Figure 8A-3. Klamath Falls August 14-19, 2021 PM2.5 and Wind Time Series

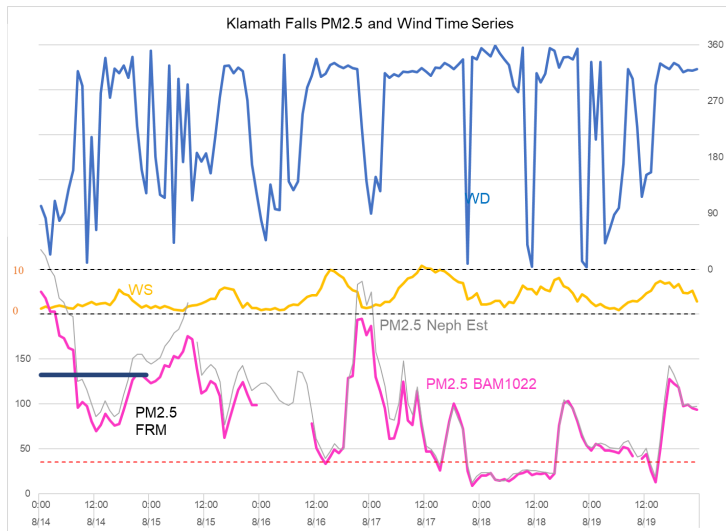


Figure A-4. Klamath Falls August 20-25 2021 PM2.5 and Wind Time Series

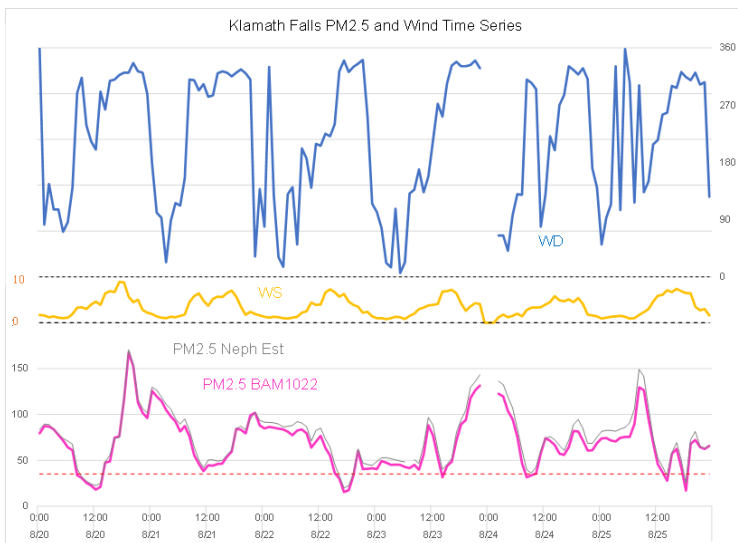


Figure 8A-5. Klamath Falls August 26-31, 2021 PM2.5 and Wind Time Series

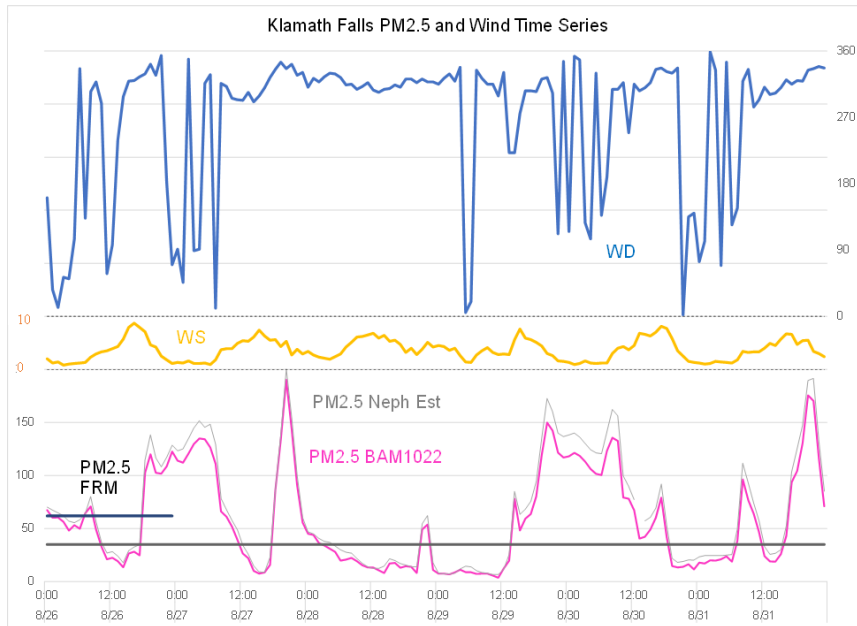


Figure 8B. August 14, 2021 Satellite Photo of Smoke Over Klamath Falls and Satellite Aerosol Optical Depth of Smoke Over Klamath Falls

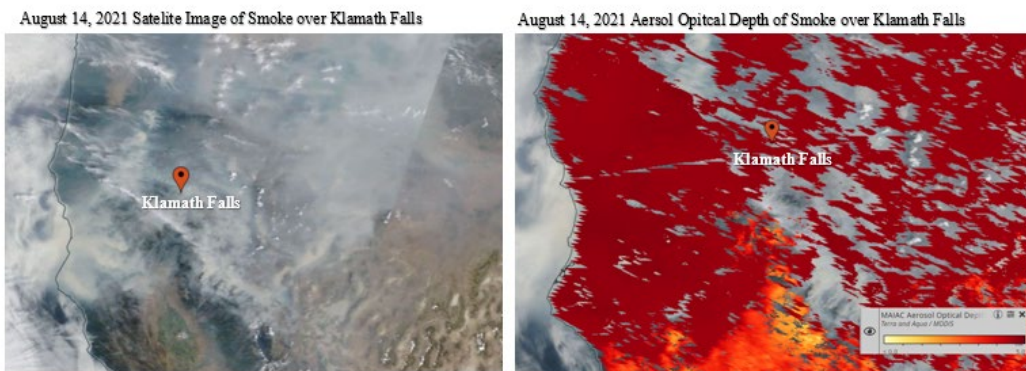
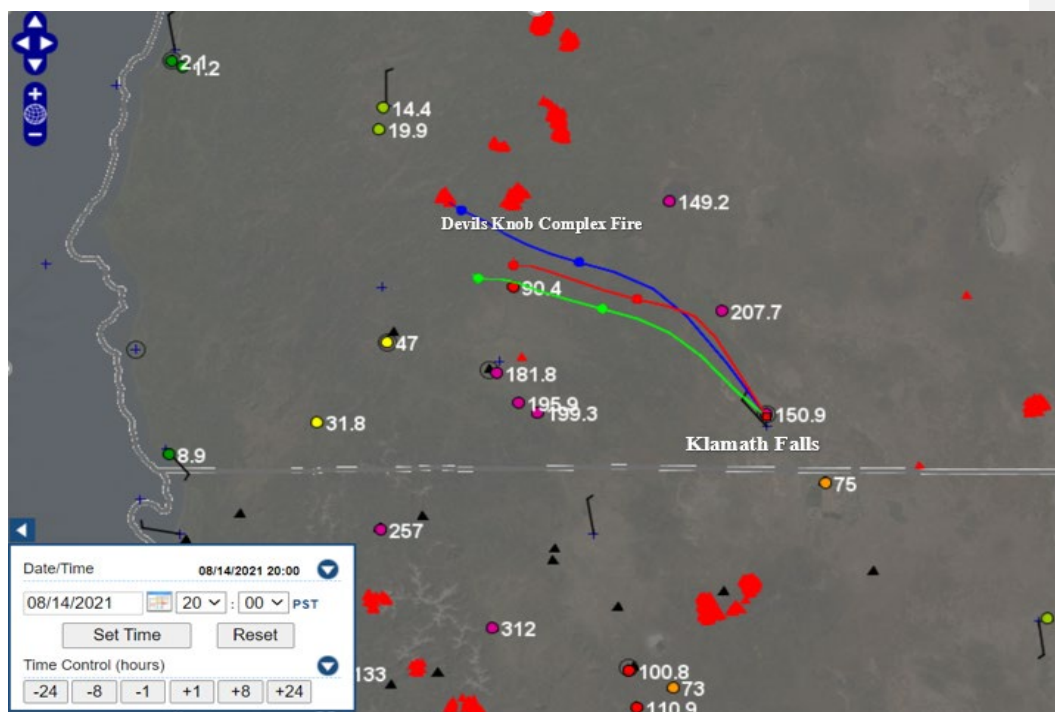


Figure 8C. August 14, 2021 HYSPLIT 12 Hour Back Trajectory from Klamath Falls



September Event | Sept 1, 2021; Sept 3-10, 2021; and Sept 15, 2021

Table 5. September Event Details (IT & RT)

Date	24-Hour Avg. PM _{2.5} (µg/m ³) EPA # 41-035-0004, POC 1			Flag
	FEM	FRM	NEPH	
9/1/2021	55.0	55.3	62.7	RT
9/2/2021	31.5	-	35.8	IT
9/3/2021	38.8	-	44.7	RT
9/4/2021	77.8	-	89.5	RT
9/5/2021	86.3	-	98.9	RT
9/6/2021	55.9	-	65.3	RT
9/7/2021	50.2	52.3	57.2	RT
9/8/2021	71.1	-	80.1	RT
9/9/2021	80.2	-	92.7	RT
9/10/2021	43.0	-	51.3	RT
9/11/2021	29.3	-	34.0	IT

2021 Klamath Falls Wildfire Exceptional Events

9/12/2021	25.3	-	30.5	IT
9/15/2021	37.9	-	41.9	RT
9/16/2021	25.1	-	27.7	IT
9/17/2021	29.5	-	33.0	IT

During the September event there were ten regulatorily significant days, and five days when PM 2.5 levels were high, due to wildfire smoke, but the monitoring values don't currently have regulatory

significance. We have included the PM_{2.5} values for all of these days in **Table 5**. Please note that RT means days with wildfire smoke impacts that do have regulatory significance and IT meanings days with wildfire smoke impacts that are being flagged for information purposes only.

In early September, smoke from the Devils Knob and Rough Patch Complex Fires continued to impact the community of Klamath Falls, as well as fires in Northern California. Monitor readings ranged between 43 ug/m³ to 86.3 ug/m³.

The Devils Knob Complex on the Umpqua National Forest is a collection of 25 wildfires started from lightning strikes primarily in mixed conifer/ponderosa forest. The Rough Patch Complex on the Umpqua National Forest started July 29, 2021 when 20-plus lightning fires resulted from thunderstorms in the area. Several more fires were added to the Complex including the Jack Fire when another storm moved through August 1, bringing the total identified fires to 42. The Monument Fire (formerly known as the Panther Fire) was a wildfire west of Big Bar in Shasta-Trinity National Forest, Trinity County, California in the United States. The fire, which was started by a lightning strike, was first reported on July 30, 2021. The Antelope Fire was first reported in the drainage of Antelope Creek in the Goosenest Ranger District of the Klamath National Forest in Siskiyou County, California on August 1, 2021, around 10:30 AM. The fire was one of many started by lightning strikes in the area during a thunderstorm. The fire was fueled by ponderosa pine, mixed conifer, and ponderosa pine which is usually very smoky.

On September 1, wildfire smoke impacted the Klamath Falls monitor. Shifting winds brought little reprieve from smoke due to forest fires in the north as well as the south. The composition of burned areas—mostly timber—created a lot of smoke. PM levels peaked in the evenings as overnight inversions trapped smoke in the Klamath Basin. Diurnal wind speeds ranged from 0 MPH to approximately 9 MPH. Elevated levels of PM were consistent for the first 10 days of September, and then started to trend lower at levels below 35 ug/m³ with the exception of 9/15. For more detail, see the time series below.

In the information provided below, **Figure 9A** shows the time series (wind speed, wind direction, and hourly PM_{2.5} readings) at the Klamath Falls Peterson School monitor from September 1 - 5, 2021, **Figure 9B** shows the time series (wind speed, wind direction, and hourly PM_{2.5} readings) at the Klamath Falls Peterson School monitor from September 6 - 15, 2021 **Figure 9C** shows the MODIS satellite data the aerosol optical depth of smoke over Klamath Falls for September 5th (the date with the highest daily average) and **Figure 9D** shows the HYSPLIT back trajectory and forwards trajectory for September 5th. Daily satellite smoke images and reverse/forward HYSPLIT trajectory modeling results are available for all September event dates and can be found in **Appendix C**.

Figure 9A. Klamath Falls September 1 - 5, 2021 PM2.5 and Wind Time Series

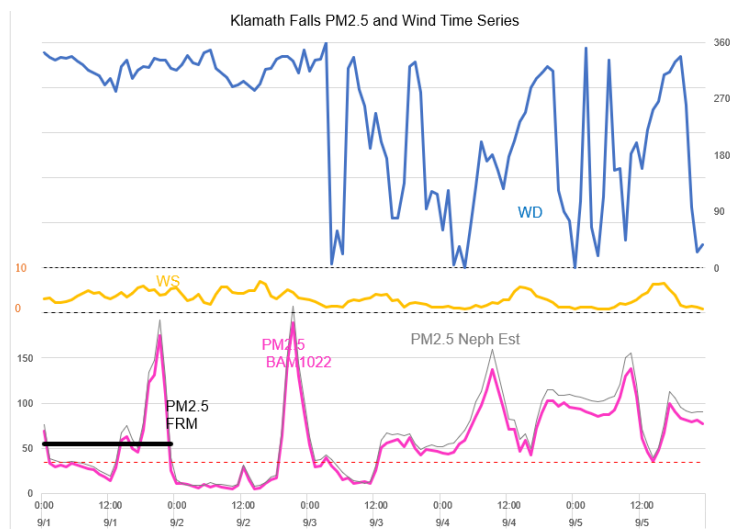


Figure 9B. Klamath Falls September 6 - 17, 2021 PM2.5 and Wind Time Series



Figure 9C. September 5, 2021 Satellite Photo with Aerosol Optical Depth of Smoke Over Klamath Falls

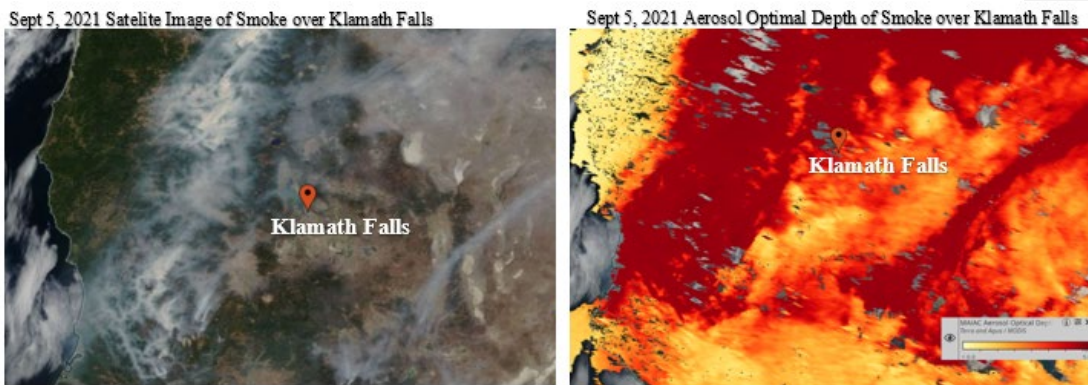
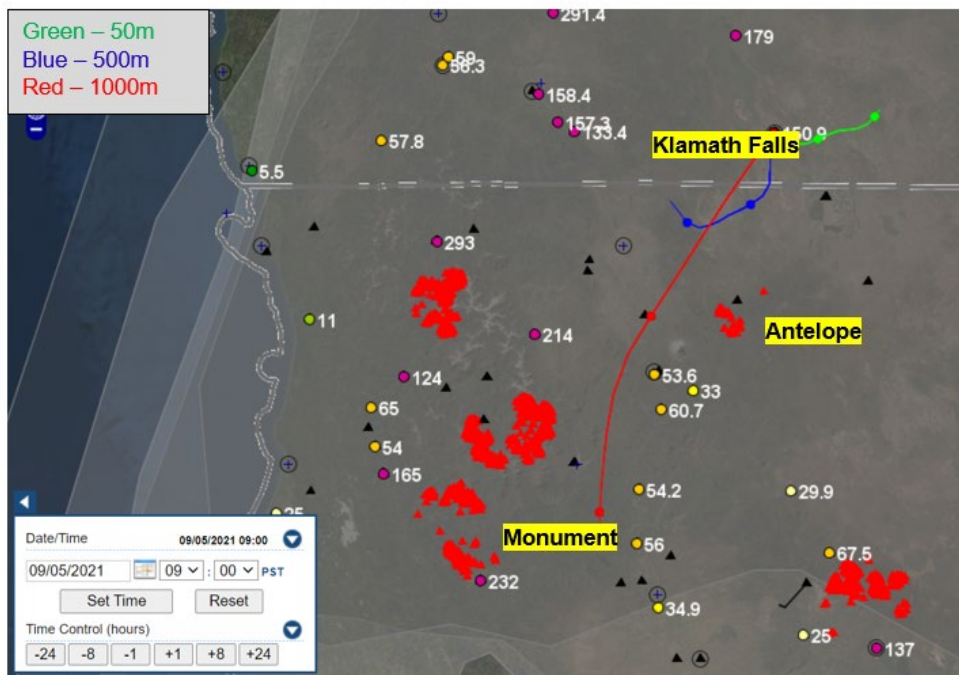


Figure 9D. September 5, 2021 HYSPLIT 12 Hour Backwards Trajectory from Klamath Falls



2 Clear Causal Relationship

DEQ has demonstrated a clear causal relationship between a source and monitor with evidence linking the source of the event to the monitored exceedance. DEQ also investigated alternative sources of PM_{2.5} and PM₁₀ and concluded alternative sources were unlikely to have contributed to monitored PM_{2.5} exceedances. Specifically, DEQ consulted:

- (1) Meteorological evidence: transport of emissions to monitor
- (2) Satellite and back trajectory evidence: spatial relationship between source and monitor
- (3) Time series evidence: temporal description of event days
- (4) Alternative sources.

2.1 Meteorological Data and Time Series

DEQ's air quality monitoring section analyzed meteorological data for each event, which has been compiled and presented in Figures 7A through 9D in section 1.3.3 of this report. DEQ used that data to identify the wildfires that most likely contributed to the PM_{2.5} monitored exceedances on smoke-impacted days.

2.2 Satellite Data, Back Trajectories and Forward Trajectories

DEQ examined MODIS Terra and MODIS Aqua satellite photos provided through NASA's EOSDIS WorldView for smoke images related to monitor sites on the flagged wildfire days. MODIS satellite photos give visual evidence of the size and direction of the smoke plume on affected days. For the days where smoke was not obviously traceable to a fire, DEQ examined Aerosol Optical Depth to identify the presence of wildfire smoke. DEQ consulted EPA's AirNowTech website to illustrate HYSPLIT back and forward trajectories. The HYSPLIT model calculates the back trajectory from the monitor to the likely wildfire smoke source. The HYSPLIT model also shows the trajectory of smoke at varying heights.

2.3 Alternative Source Hypotheses

DEQ explored alternative sources of PM_{2.5} and PM₁₀ on wildfire-impacted days. Anthropogenic alternative sources include prescribed fires, crop residue burning, residential wood combustion, open burning, and vehicle emissions. These anthropogenic sources maintain relatively steady emissions from year to year and are included in historical monitor values.

2.3.1 Prescribed Burning

The Oregon Department of Forestry declared fire season in portions of the state as early as May 15, 2021, and no prescribed burns were authorized or reported in Klamath Falls area for the impacted monitor days. Fire season for most of the state ended in early October, but Klamath-Lake, Northeast Oregon and Walker Ranger Forest didn't declare the end of fire season until October 22nd, 2021.⁶

2.3.2 Crop Residue & Agricultural Burning

Crop residue burning is regulated in Oregon by the Oregon Department of Agriculture in conjunction with multi-agency smoke management efforts, including the Oregon Department of Forestry, Oregon Department of Environmental Quality, and the Oregon State Fire Marshal. ODA's field burning rules are listed in OAR 603-077, "Field Burning Rules," for the Willamette Valley only. The open burning of all other agricultural waste is governed by OAR 340-264, "Rules for Open Burning," and covered in section 2.3.4.

⁶ <https://katu.com/news/wildfire-season/oregon-department-of-forestry-declares-end-to-2021-fire-season>.

2.3.3 Residential Wood Combustion

Residential wood combustion can be a significant source of PM_{2.5} emissions in Oregon communities during the winter months. The temperatures in Klamath Falls on the majority of dates in question were well above the temperatures at which residents would likely be burning wood for residential heating.

2.3.4 Open Burning

Open burning in Oregon is regulated by OAR 340-264.⁷ Oregon:

“Classifies all open burning into one of seven classes: Agricultural; Commercial; Construction; Demolition (which includes land clearing); Domestic (which includes burning commonly called “backyard burning” and burning of yard debris); Industrial; or Slash. Except for field burning within the Willamette Valley regulated through OAR 340 division 266 and slash burning administered by the forest practices smoke management plan of the Oregon Department of Forestry, this division prescribes requirements for and prohibitions of open burning for every location in the state. Generally, if a class of open burning is not specifically prohibited in a given location, then it is authorized subject to OAR 340-264-0050 and 340-264-0060 and the requirements and prohibitions of local jurisdictions and the State Fire Marshal.”

In addition, according to OAR 340-262-0900, “Materials Prohibited from Burning:”

No person may cause or allow any of the following materials to be burned in a solid fuel burning device, fireplace, a trash burner or any other device described in ORS 468A.485(4)(b):

(1)(a) Garbage; (b) Treated wood; (c) Plastic or plastic products; (d) Rubber or rubber products; (e) Animal carcasses; (f) Products that contain asphalt; (g) Waste petroleum products; (h) Paint; (i) Chemicals; (j) Products containing lead, mercury or other heavy or toxic metals; (k) Materials containing asbestos; and (l) Particleboard.

(2) Paper or paper products, except for paper used to kindle a fire.

No open burning was allowed in Klamath Falls during the 2021 wildfire season and across the state a voluntary refrain from all outdoor burning was in effect.⁸

2.3.5 Vehicle Emissions

Vehicle emissions and road dust produce PM_{2.5} emissions and are included in the onroad mobile source category in the national emissions inventory. The annual PM_{2.5} emissions in this category are a small fraction of PM_{2.5} emissions overall and those produced by wildfires, especially in rural areas like Klamath Falls which has relatively few vehicles. The Klamath Falls Fine Particulate Matter (PM_{2.5}) Attainment Plan (DEQ 2012)⁹ models onroad emissions contributions to PM_{2.5} levels as “minimal.” Onroad mobile emissions did not likely contribute any significant PM_{2.5} to the elevated concentrations at the monitors in question on the impacted days.

⁷ Oregon Secretary of State website. “Rules for Open Burning.” (Accessed 6/8/2020)

<https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=1568>

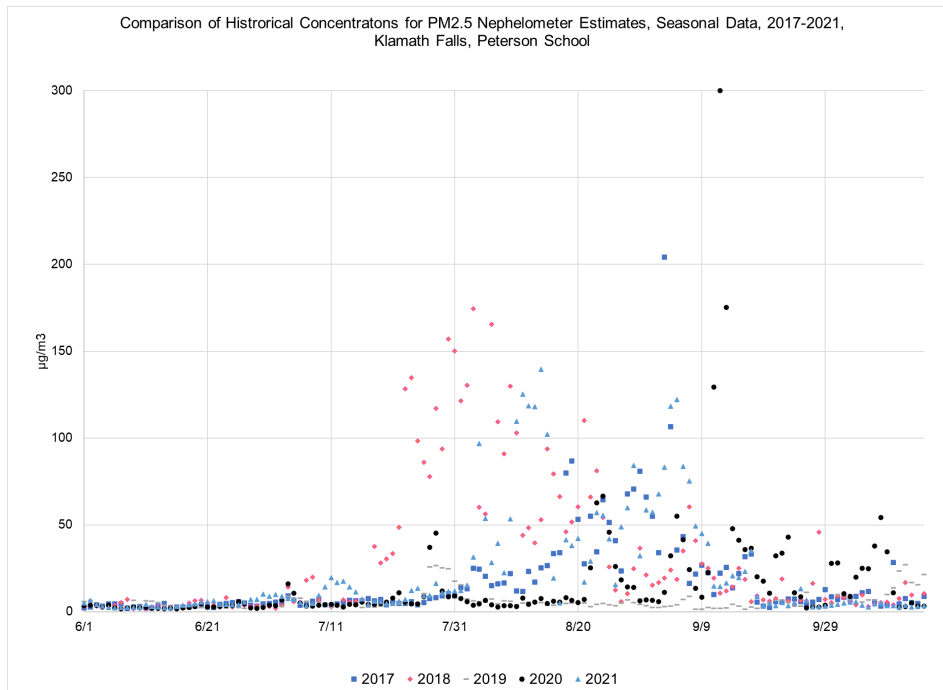
⁸ Details on the ask to voluntarily refrain from outdoor burning. <https://deqblog.com/2020/04/08/state-agencies-ask-oregonians-to-voluntarily-refrain-from-outdoor-burning-while-communities-respond-to-covid-19/>

⁹ Oregon Department of Environmental Quality. 2012. *Klamath Falls Fine Particulate Matter (PM_{2.5}) Attainment Plan*. Portland, OR. <https://www.oregon.gov/deq/FilterDocs/KFallsAttPlan2012.pdf>

3 Comparison to Historical Fluctuations

To support the clear causal relationship requirement of the EER, DEQ compared the event-influenced concentrations at Klamath Falls to historical concentrations. **Figures 11** and **Figure 12** show the PM_{2.5} concentrations measured at Klamath Falls for 2017 through 2020.

Figure 11. Historical Comparison of Seasonal PM_{2.5} Concentrations at Klamath Falls Peterson School Monitor measured with Nephelometer



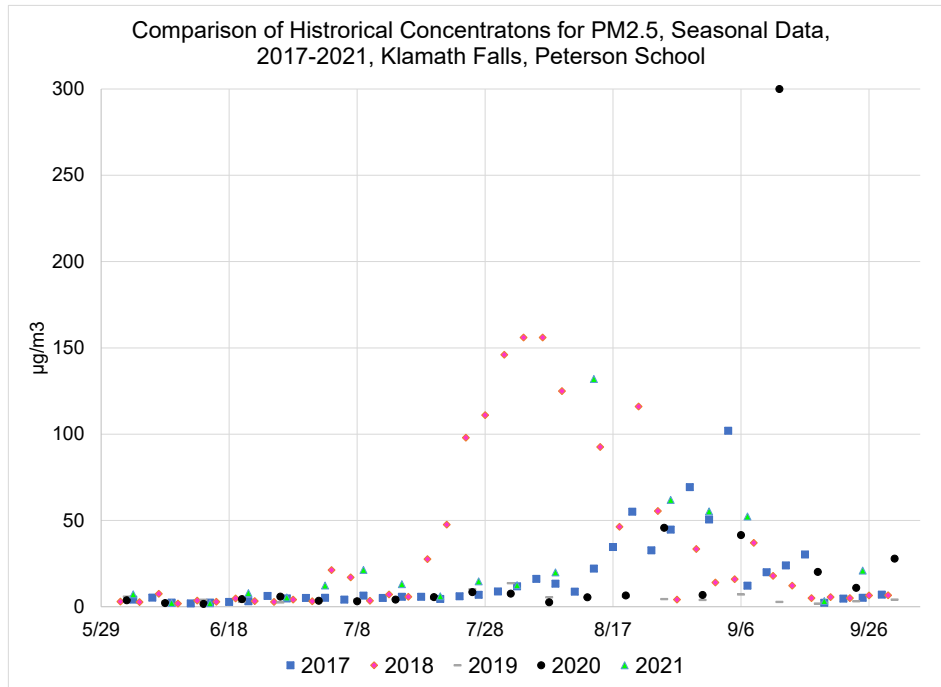
Commented [CV20]: Consider clarifying that this is the summer season.

Commented [KR21]: Also in the spirit of simplifying EE demos, the key year in this plot is 2019, being the year with the lowest wildfires as per Figure 1. The most powerful plot would be data from 2011, 2013, 2016, and 2019 and compared to 2021.

If all the data that's available is 2017-2021, then this plot is fine.

Figure 12. Historical Comparison of Seasonal PM2.5 Concentrations at Klamath Falls Peterson School Monitor measured with FRM

Commented [KR22]: Same comment as above.



This data shows that during wildfire season PM2.5 measurements typically remain below 35 ug/m3 with in Klamath Falls, if no wildfires are occurring. Higher PM2.5 measurements in the wintertime are attributed to residential wood combustion and wintertime inversions in our mountain valleys.

The exception is when there are wildland fire smoke incursions during the summer months. Summer background PM2.5 measurements are low on the vast majority of days. DEQ analyzed June through September data for 2011 through 2019 to establish a background level. DEQ used FRM data when available and otherwise used PM2.5 estimates from the nephelometer.

Table 6 shows that 2021 PM2.5 readings were exceptional, even given wildfire years between 2011 through 2020.

Table 6. Basic Descriptive Statistics for 24-hr PM2.5 Concentrations Recorded at Peterson School Monitor in Klamath Falls, OR from 2011 – 2021, including all data

	2011-2020 w/ wildfire (ug/m ³)			2011-2020 w/ no wildfire (ug/m ³)			2021 (all data) (ug/m ³)		
	T640x	Neph	FRM	T640x	Neph	FRM	T640x/BAM1022	Neph	FRM
Minimum	0.6	0.9	0.6	0.6	0.9	0.6	2.1	0.9	1.5
Maximum	458	282	300	59	53.2	50	133/ 36	162	132
Median	7.2	6.6	6.4	6.8	6.3	6.2	10.4/ 8.2	6.9	7.0

Commented [KR23]: More in the spirit of simplifying EE demos:

These stats don't add much to the demonstration. However, if you limited the data to summer months, then that would provide some compelling information (assuming the max value after removing wildfire days was < than the standard).

Commented [CV24R23]: Also in the spirit of simplifying, would it be ok to remove the table?

Commented [KR25R23]: Sounds good to me.

2021 Klamath Falls Wildfire Exceptional Events

Mean	11.9	11.0	11.9	9.8	9.4	9.0	18.5/11.5	15.7	13.7
Std.Dev	20.3	14.7	17.0	8.9	7.9	7.8	10.2/ 7.9	24.4	19.9
N	1642	3617	1054	1566	3476	1014	359/309	365	59

Table 7 shows how excluding 2021 wildfire-influenced measurements affects the 2021 PM2.5 measurement statistics (note the lower numbers in the far right column of Table 7 compared to the same column in Table 6.

Table 7. Basic Descriptive Statistics for 24-hr PM2.5 Concentrations Recorded at Peterson School Monitor in Klamath Falls, OR from 2011 – 2021, excluding wildfire data

	2011-2020 w/ wildfire (ug/m ³)			2011-2020 w/ no wildfire (ug/m ³)			2021 (excluding wildfire data) (ug/m ³)		
	T640x	Neph	FRM	T640x	Neph	FRM	T640x/BAM1022	Neph	FRM
Minimum	0.6	0.9	0.6	0.6	0.9	0.6	2.1	0.9	1.5
Maximum	458	282	300	59	53.2	50	36	29	24
Median	7.2	6.6	6.4	6.8	6.3	6.2	8.2	5.7	6.1
Mean	11.9	11.0	11.9	9.8	9.4	9.0	11.5	8.2	9.0
Std.Dev	20.3	14.7	17.0	8.9	7.9	7.8	7.9	5.7	6.1
N	1642	3617	1054	1566	3476	1014	309	313	55

Commented [KR26]: Same comment as above.

4 Not Reasonably Controllable or Preventable

This EER element requires a demonstration that the event(s) were neither reasonably controllable nor preventable. DEQ has met the requirements of 40 CFR 50.14(b)(4) by presenting the evidence in **Section 1** and **Section 2** of this report. DEQ contends that the events of July, August and September of 2021 at Klamath Falls were not reasonably controllable or preventable.

5 Natural Event or Human Activity Unlikely to Recur (NE/HAUR)

The EER requires that agencies must document that the identified source of an exceptional event is either a natural event or a human activity unlikely to recur at the same location and affect the monitors in question again. Although many wildfires may be ignited due to human activity, the large fires in 2021 were largely due to lightning strikes that occurred during a record-breaking hot and dry summer season. These lightning-caused wildfire events are considered natural events. The detailed data included in **Section 1** and **Section 2** demonstrate a clear causal relationship between source and monitor for each day that ODEQ requests concurrence. Thus, the NE/HAUR criterion of 40 CFR 50.14(b)(4) is satisfied.

6 Mitigation

The EER requires states to take appropriate and reasonable actions to protect public health from exceedances or violations of the NAAQS (40CFR 51.930). DEQ presents evidence of prompt public notification of the event, public education so that individuals could make behavioral changes to reduce exposure to unhealthy air, and implementation of appropriate measures to protect public health from the impacts of exceptional events.

Control of wildland fires is coordinated under the National Interagency Fire Center, in which DEQ participates. Their fire control policy states:

Five federal agencies, including the Department of the Interior's Bureau of Land Management, Bureau of Indian Affairs, National Park Service, and U.S. Fish and Wildlife Service, along with the Department of Agriculture's Forest Service, manage and have primary fire program

responsibilities on more than 676 million acres. The U.S. Fire Administration works with county and local fire departments; while the states are represented by the National Association of State Foresters. The state, county, and local jurisdictions provide primary fire protection on public and private lands covering additional hundreds of millions of acres across all 50 states.

As partners, they work together on fire management issues covering the spectrum from safety and planning, to science, preparedness, operations, strategy development, logistics, intelligence, emergency response, and more. They also collaborate on interagency strategies to manage wildfires, not only for single incidents but as a matter of policy.

In addition to the total effort of the various natural resource agencies, the specific USFS districts prepare fire management plans.¹⁰

Oregon DEQ, Lane Regional Air Pollution Authority, Oregon Health Authority, Oregon OSHA, Oregon Emergency Management, Oregon Department of Forestry, and the US Forest Service developed a wildfire response protocol which outlines the state, federal, and local response to dangerous smoke levels impacting Oregon communities.¹¹ The protocol defines which agency is responsible for which activity and provides a guide for the coordination of emergency communication during extreme smoke events. The major areas of agency actions and the lead agencies responsible in the event of a severe smoke episode related to wildfire are presented in detail in **Table 8**.

Table 8. Wildfire Response Protocol: Actions and Agencies Responsible		
Action Needed	Lead Agency and Action Taken	Desired Outcome
1. Air Monitoring		
Measuring ambient air quality	Mostly DEQ as lead agency. Air Resource Advisors (ARA) may provide additional monitoring equipment via national cache resources and assist in deployment and data collection.	Ability to track ambient air quality levels in communities receiving the heaviest impact, and identify smoke-free areas where air quality is good.
Indoor air quality exposure	Oregon OSHA is lead agency to evaluate air quality concerns for workers. DEQ and OHA can provide advice to schools.	Ability to monitor indoor smoke levels in work environments and schools.
2. Smoke Forecasting and Modeling		
Smoke weather forecast	ODF is the lead agency, with back-up and assistance from NWS Meteorologists as requested. DEQ assists in coordination. National Weather Service can be contacted to provide “spot weather forecasts” for wildfire.	Provide advance notice of possible smoke movement and impacts, improve public notification, lower risk of public exposure to high smoke levels
Smoke modeling	ARAs can provide smoke modeling forecasts if requested.	Complementary to above
3. Issuing Health Warnings		
Provide public with frequent smoke	Coordination between the Incident Management Team, DEQ, ARA, OHA,	Frequent coordinated updates provided to the public via

¹⁰ For more details for fire science reports and community outreach practices, see: USDA Forest Service – Fire Science and report page. <https://www.fs.usda.gov/detail/r6/fire-aviation/?cid=fseprd604078> (Accessed 6/8/21)

¹¹ Oregon DEQ et al. 2020. *Oregon Wildfire Response Protocol for Severe Smoke Episodes*. V7 June 10, 2020. <https://www.oregon.gov/deq/FilterDocs/WFResponse.pdf> (Accessed 6/8/21)

updates on potential health risk and recommended public health actions via the web and media	county health departments, local government, tribes and 211 info. Assistance from federal land managers on fire status, and from ODF wildfire forecasting.	Oregon Smoke Blog, DEQ, OHA, local government websites, press releases and media outreach. 211 info is provided with up-to-date health-related information.
4. Website management		
Updating the Oregon Smoke Blog and social media (see description under section 6)	Blog initiated by federal land managers or DEQ, and updated by DEQ Public Affairs who will act as a “gate keeper” to avoid duplicative messaging and crowding of the smoke blog.	Provide the public with comprehensive “one-stop” website/social media on wildfire status, air quality levels, health risk, cleaner air spaces, press releases and other critical info.
Updating DEQ, OHA, ODF and local websites	Managed by respective agency. Supplements the Oregon Smoke Blog website.	Complements the above website.
5. Public Actions		
Cancel or modify public events, outdoor and business activities	Decision made within affected jurisdiction, by local or tribal health authorities in consultation with DEQ, ARA, local public health, OHA, federal land managers, and possibly or OR-OSHA as needed.	Prompt action taken, via notification of media, 211 info, and posting info on Oregon Smoke Blog and other websites
Consult with schools on limited hours or closure. Decisions about protecting schools or other public buildings from smoke intrusion	Decision made within affected jurisdiction, by local or tribal health authorities in consultation with DEQ, ARA, local public health, OHA, or OR-OSHA as needed.	Identification of measures to protect schools and users of public buildings from smoke
Set up general population shelters	Red Cross may support the setup and management of general population shelters based on decisions by local health officials.	When determined necessary, general population shelters will be established and opened in coordination with local public health and emergency management.
Establish or identify public cleaner air spaces	Decisions made within affected jurisdiction, by local or tribal health authorities in consultation with DEQ, ARA, OHA, or OR-OSHA as needed.	When determined necessary, prompt action taken to set up or identify cleaner air spaces, using guidance for “Identification of Cleaner Air Spaces for Protection from Wildfire Smoke” ¹
Recommended evacuation/relocation of sensitive populations	Decision made at local level, by health officials and tribal/local government (Sheriff or local emergency management), OEM, in consultation with DEQ, ARA, OHA, federal land managers and possibly OR-OSHA	Prompt action taken if dangerous smoke levels are expected to persist for a prolonged period. Requires close communication with DEQ, OHA, federal land managers, OEM, OR-OSHA,

		211 info, and possibly Red Cross, State Fire Marshal and State Police.
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7 Initial Notification

The EER establishes specific procedural requirements that an air agency must follow to request data exclusion. Those requirements and ODEQ's actions to meet them are summarized in the table below.

Table 9. Exceptional Event Rule Procedure Requirements	
Exceptional Event Rule Procedural Requirement	ODEQ Action/Intended Action
A State shall notify EPA of its intent to exclude one or more measured exceedances of an applicable ambient air quality standard as being due to an exceptional event by placing a flag in the appropriate field for the data record of concern which has been submitted to the AQS database. 40 CFR § 50.14(c)(2)(i).	ODEQ notified EPA that it placed flags on numerous the monitor values originally thought to be affected by wildfires above the level of concern in Oregon for PM2.5 of 25µg/m3 and that we intended to request EPA concurrence to exclude some or all of them from the AQS database.
A State that has flagged data as being due to an exceptional event and is requesting exclusion of the affected measurement data shall, after notice and opportunity for public comment, submit a demonstration to justify data exclusion to EPA. EPA shall respond with a due date for demonstration submittal that considers the nature of the event and the anticipated timing of the associated regulatory decision. 40 CFR § (50.14(c)(3)(i)).	DEQ made this package available for public comment and subsequently submitted it to EPA by {DATE} so that it continues to demonstrate Klamath Falls is meeting the 24-hour PM2.5 standard.
With the submission of the demonstration, the air agency must document that the public comment process was followed. 40 CFR § (50.14(c)(3)(iv) and (v).	This document was available for a 30-day public comment from {DATE} until {DATE}

DEQ posted notice of this exceptional events demonstration on {DATE} on the DEQ website. Written comments were due by 5 p.m. on {DATE}, and could be submitted by mail, fax or email.

Figure 13. DEQ Makes a Statewide Request for Public Comment on Klamath Falls 2021 Exceptional Event Demonstration.

{SCREEN SHOT HERE!}

8 Public Comment

{DETAILS ABOUT WHAT PUBLIC COMMENTS WERE RECEIVED}

9 Summary

With the weight of evidence discussed throughout this report, Oregon DEQ has shown that the smoke from the 2021 Oregon and California wildfires caused the PM2.5 concentration collected on the ODEQ Federal Reference Method air quality monitor in Klamath Falls in July, August, and September of 2021. ODEQ requests EPA's concurrence and that these values not be used to calculate the relevant design values for the Klamath Falls State Implementation Plan. ODEQ is also submitting some dates for which EPA will not concur at the moment, but for which the information may become of regulatory significance in the future.